



Parallel Streamlines in VisIt

Dave Pugmire (ORNL)

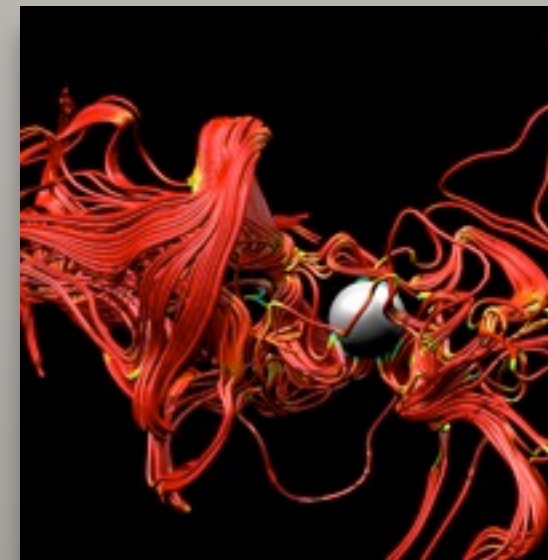
www.vacet.org

Parallel streamlines highlights

- **What is the problem?**
 - Inability to analyze vector fields at scale
- **What did you do?**
 - Designed scalable data-parallel integral curve methods
 - Implemented and deployed in VisIt
- **What was the impact?**
 - Astro: magnetic field analysis for the first time
 - Fusion: extraction of magnetic islands at scale
 - Fluid Flow: analysis of nuclear reactors and fishtank experiment

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Parallel Streamline Team



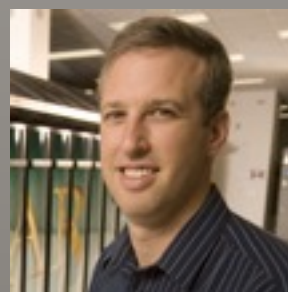
Dave Pugmire
ORNL



Hank Childs
LBL/UCDavis



Christoph Garth
UCDavis



Sean Ahern
ORNL



Gunther Weber
LBL

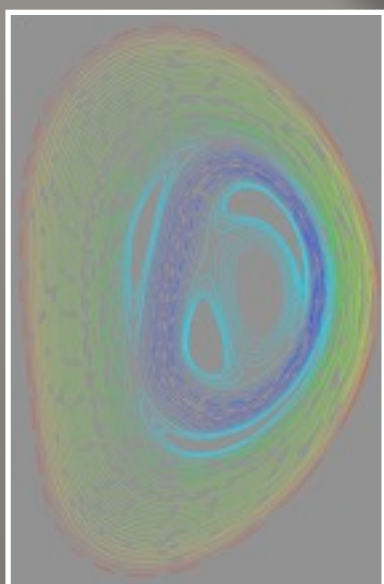
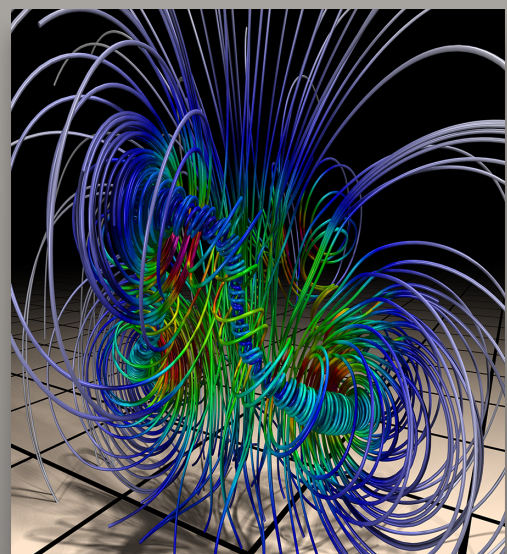
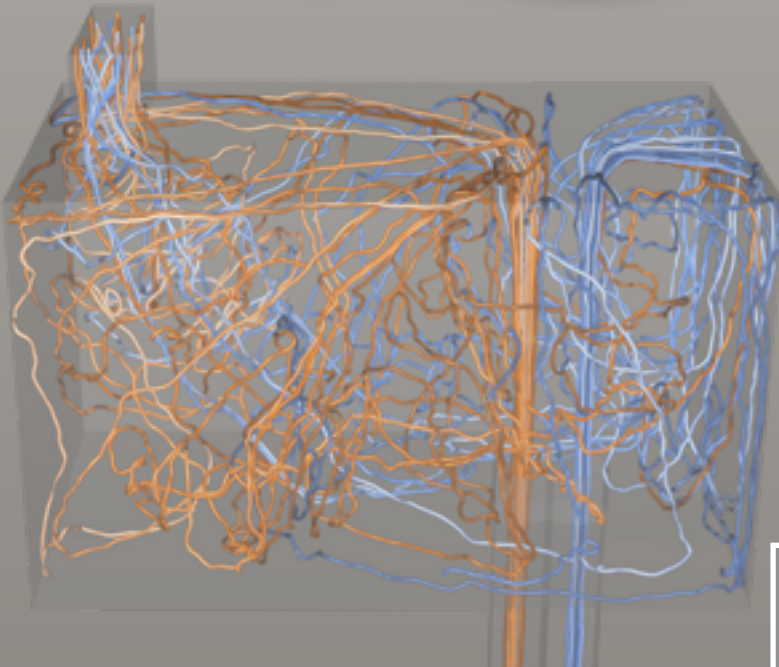
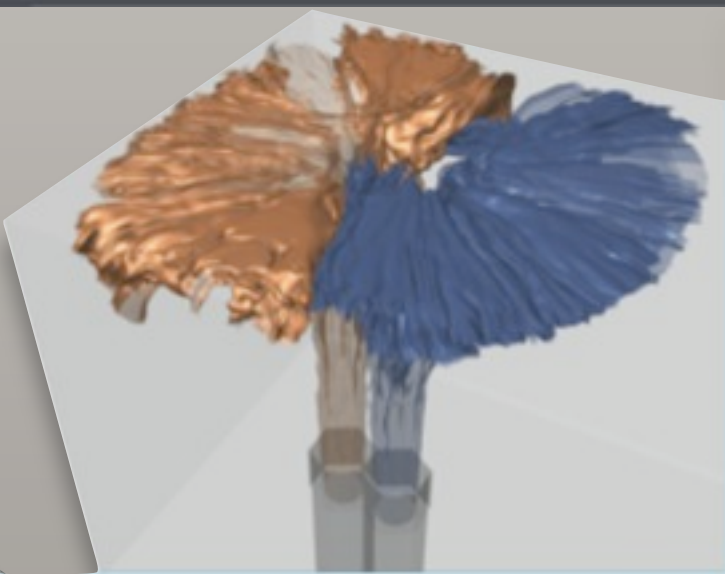
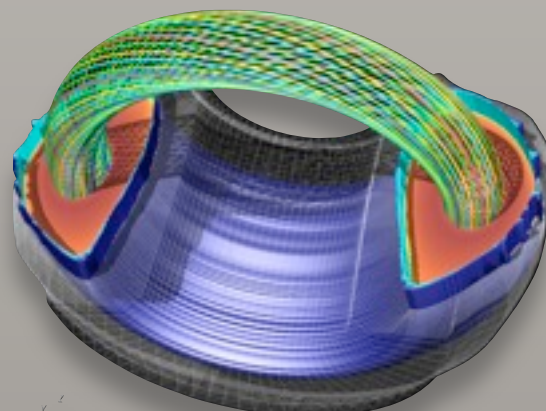
Science Stakeholders

- Fusion
 - Tech-X, ORNL, PPPL, NYU, Cal Tech
- Turbulent flows
 - Stanford, ANL
- Astrophysics
 - ORNL, UTennessee
- Solvers
 - APDEC

Scientific Impact



Scientific Impact



Accomplishments

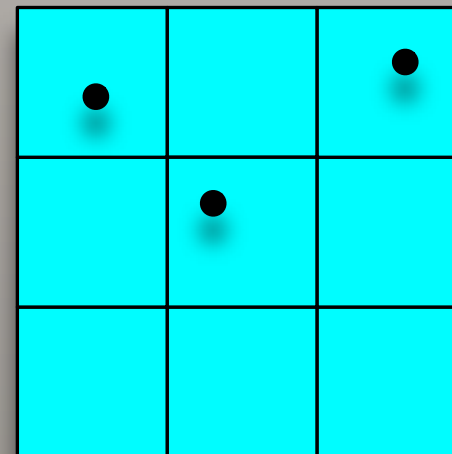
- Deployment in VisIt 1.12
 - Enhancements, new features, bug fixes 1.12.1, 1.12.2, 2.0beta
- Poincaré Analysis Support in VisIt 1.12
 - Details in Allen Sanderson's talk
- Paper accepted in SC09

“Scalable Computation of Streamlines on Very Large Datasets.”,
Pugmire, Childs, Garth, Ahern, Weber
- Presentations:
 - Cray Users Group Meeting
 - SIAM Conference on Parallel Processing for Scientific Computing

Scalability of Streamline Algorithms

Barriers to scalability

1. Dataset size
2. Number of seeds
3. Seed distribution
4. Vector field complexity



P0

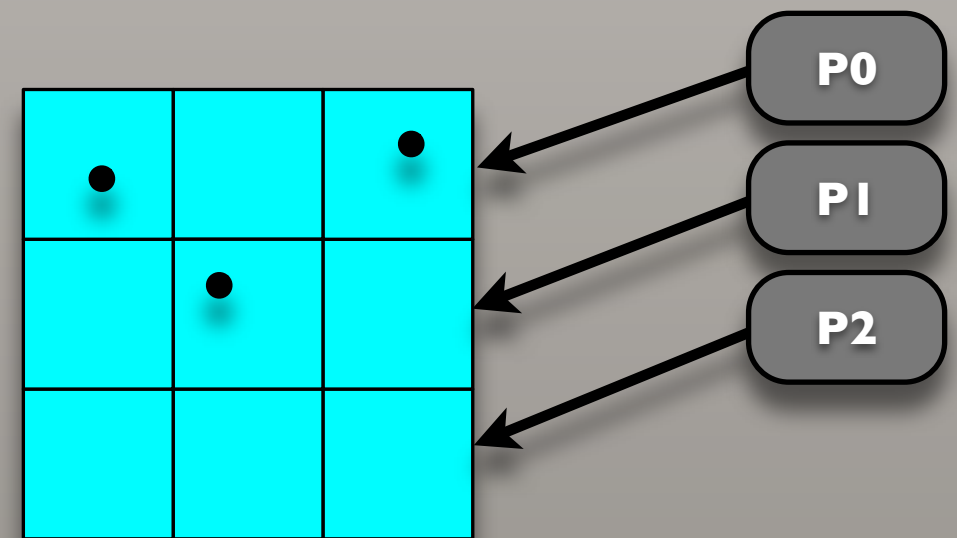
P1

P2

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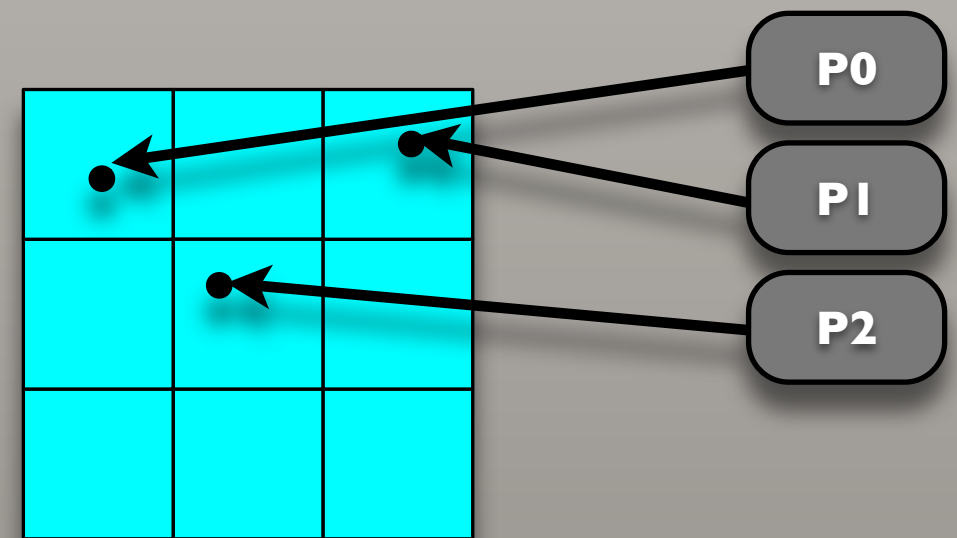


Parallelization over blocks

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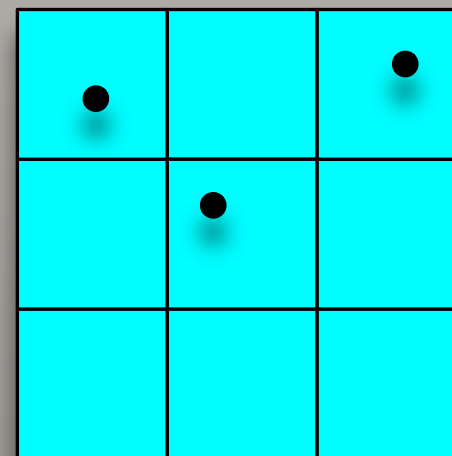
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Parallelization over seeds

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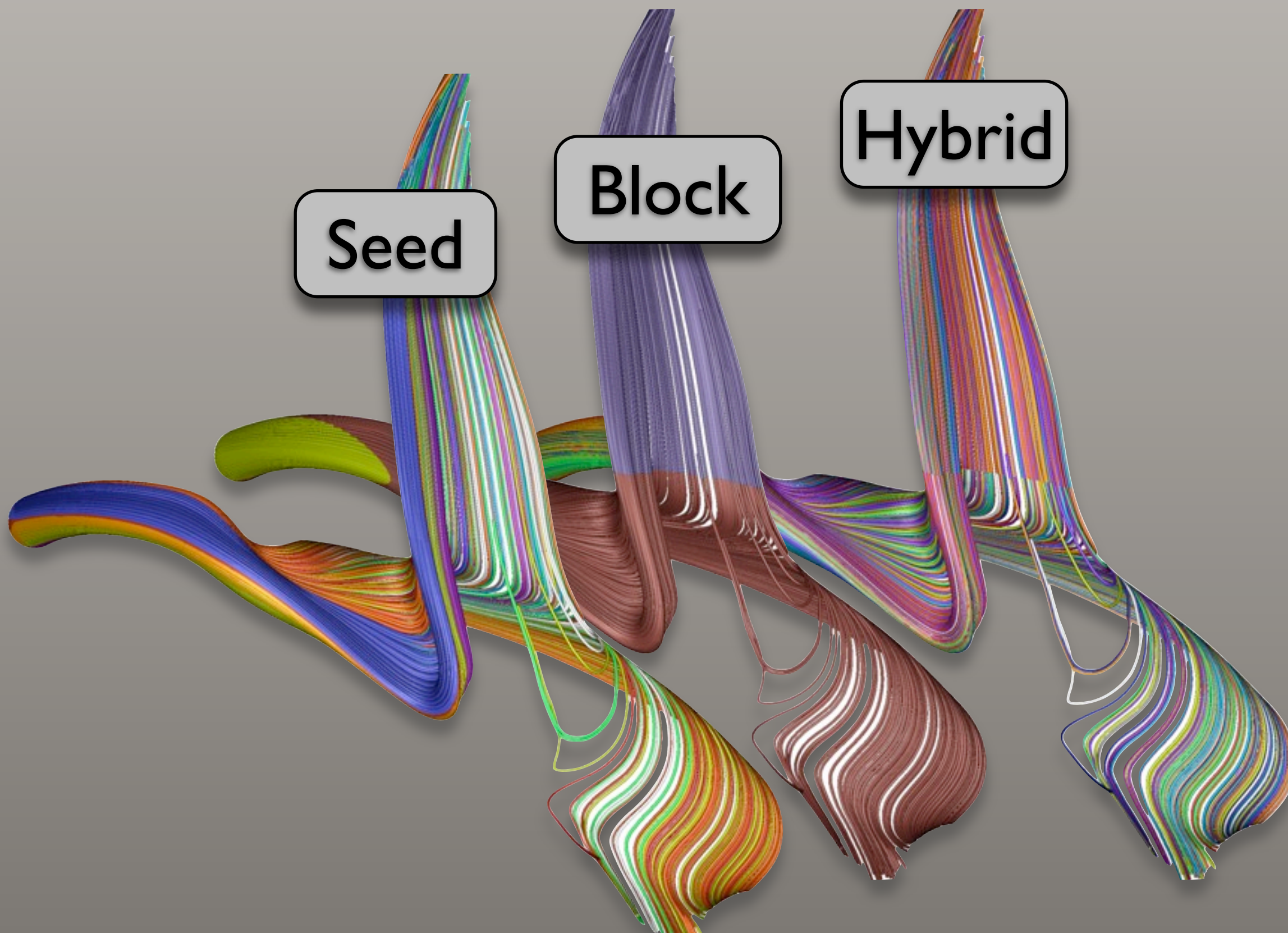
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Parallelization over blocks

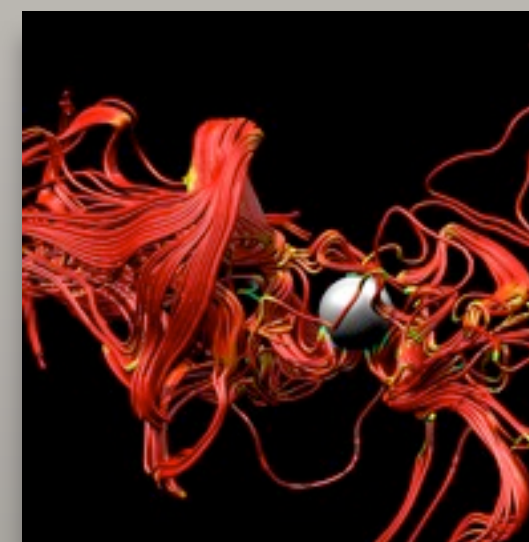
Parallelization over seeds

Hybrid Parallelization

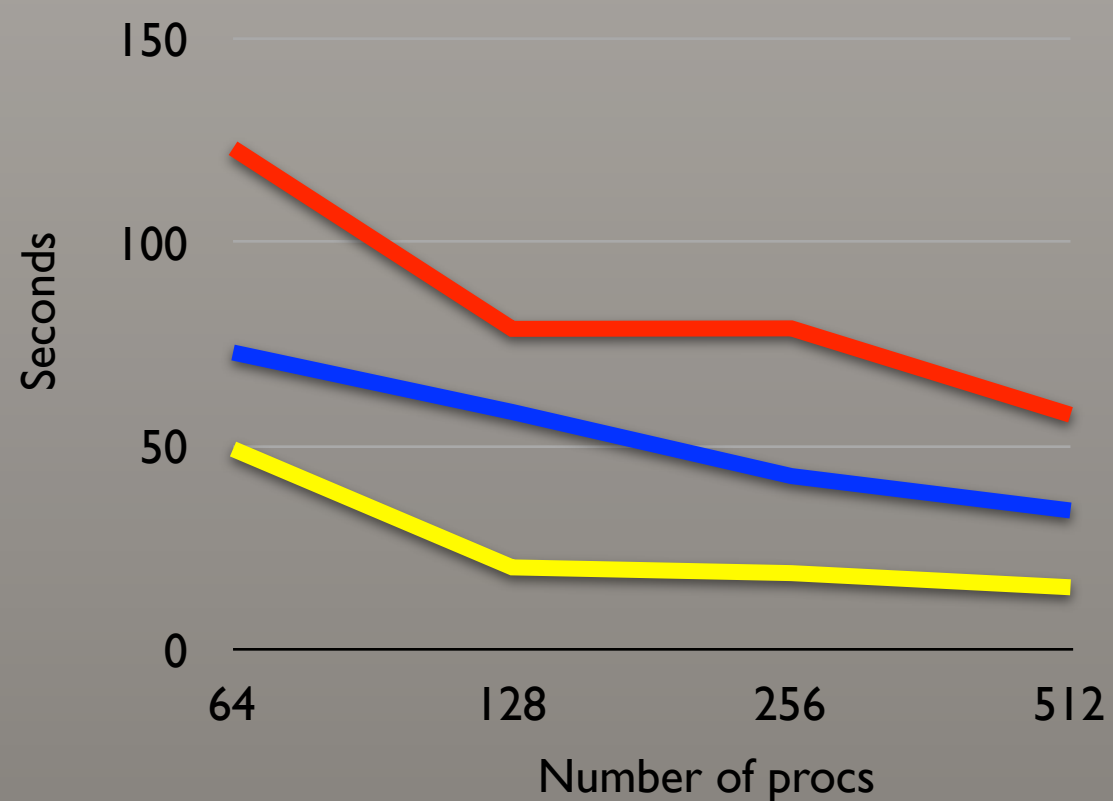
Comparison of Workload Distribution



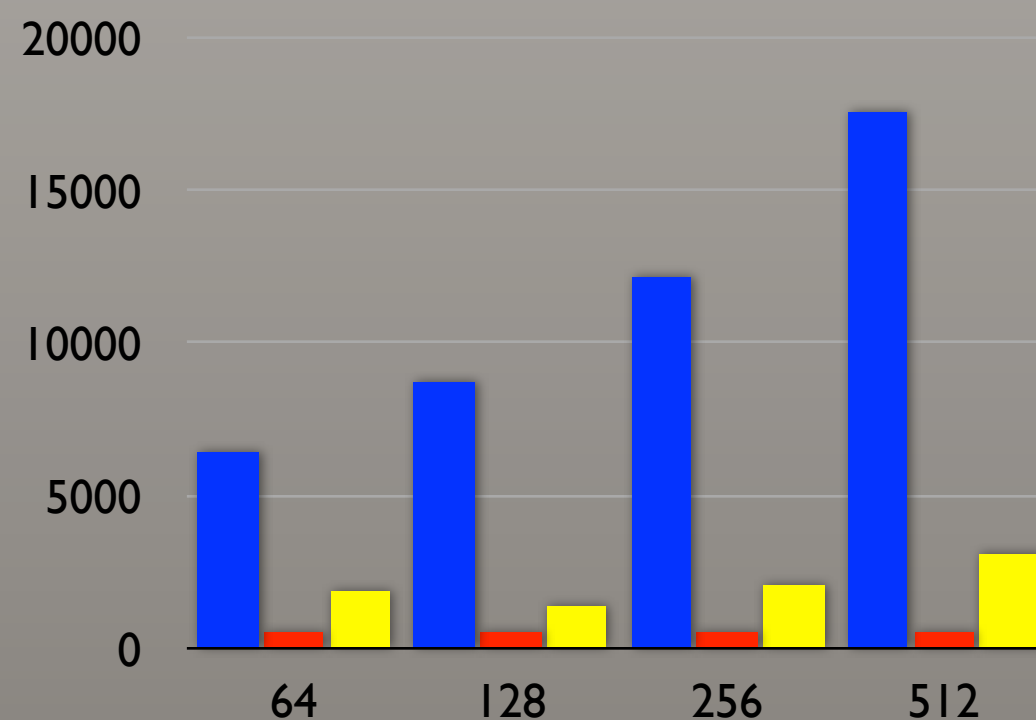
Astrophysics Test Case: Integrating 20,000 seed points



Time requirements



I/O requirements



Seed

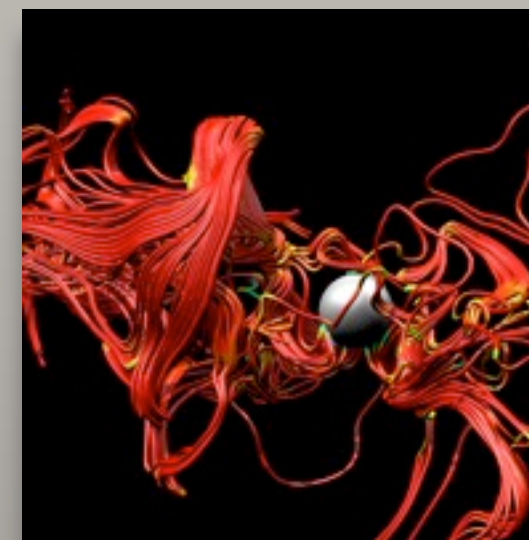


Block

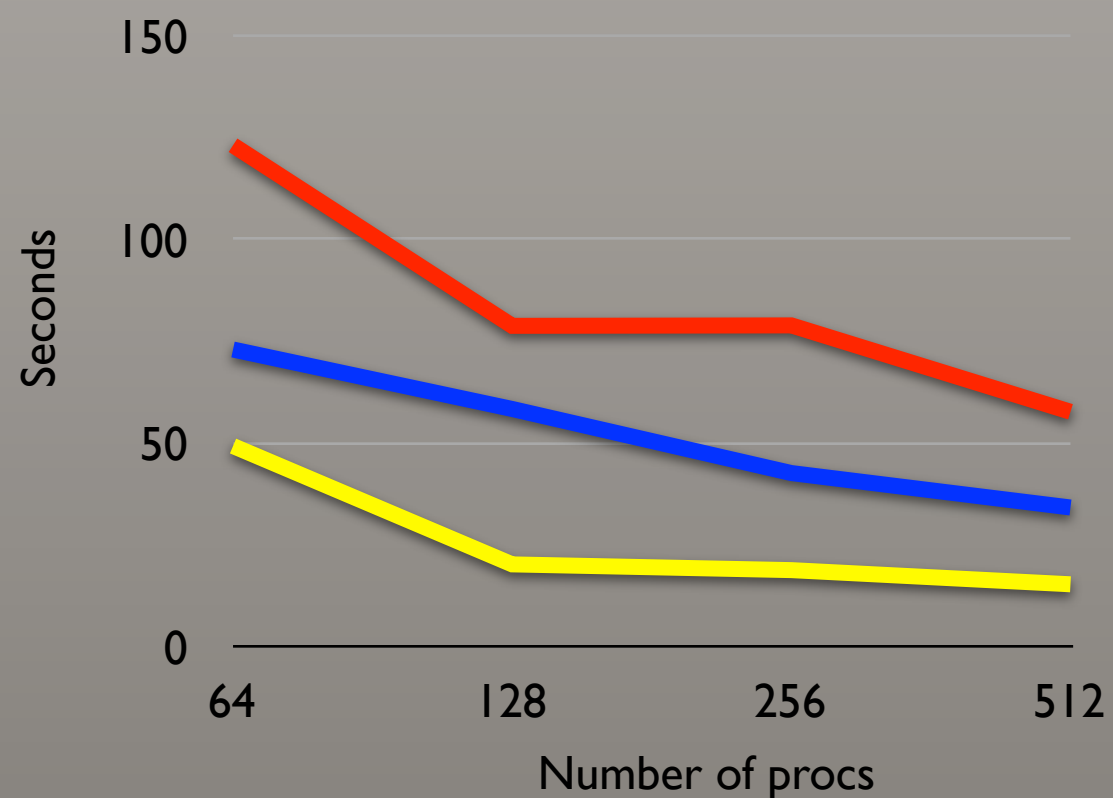


Hybrid

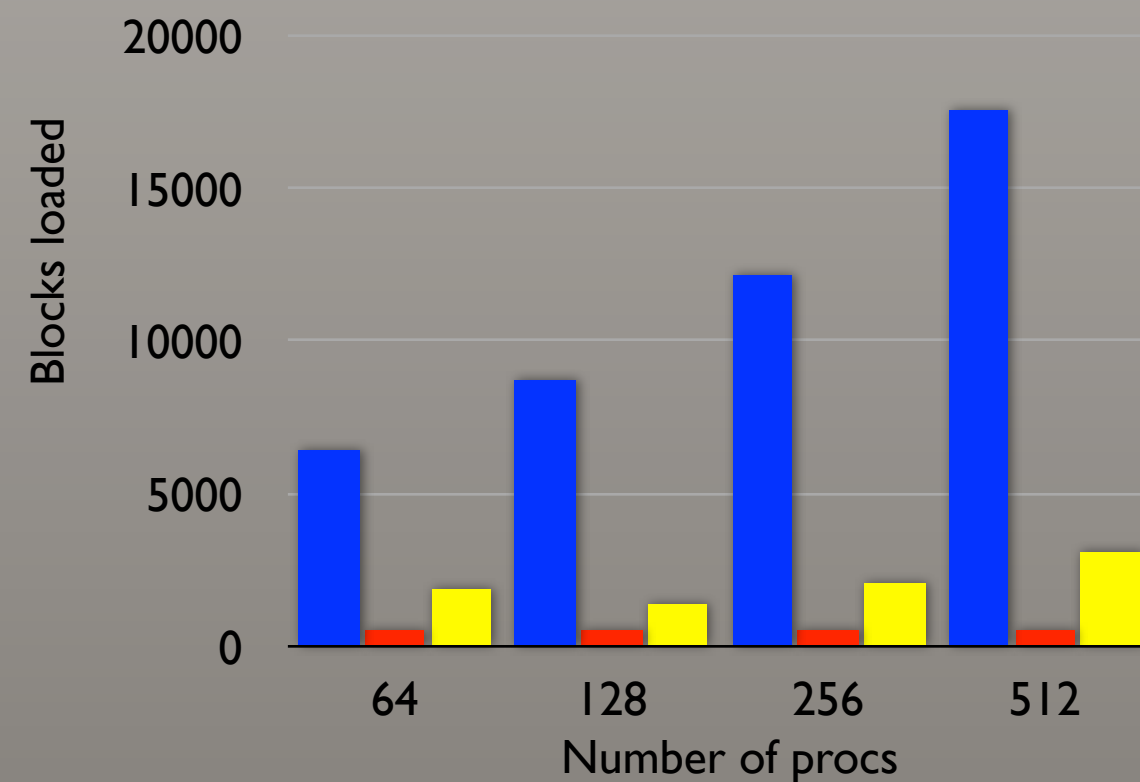
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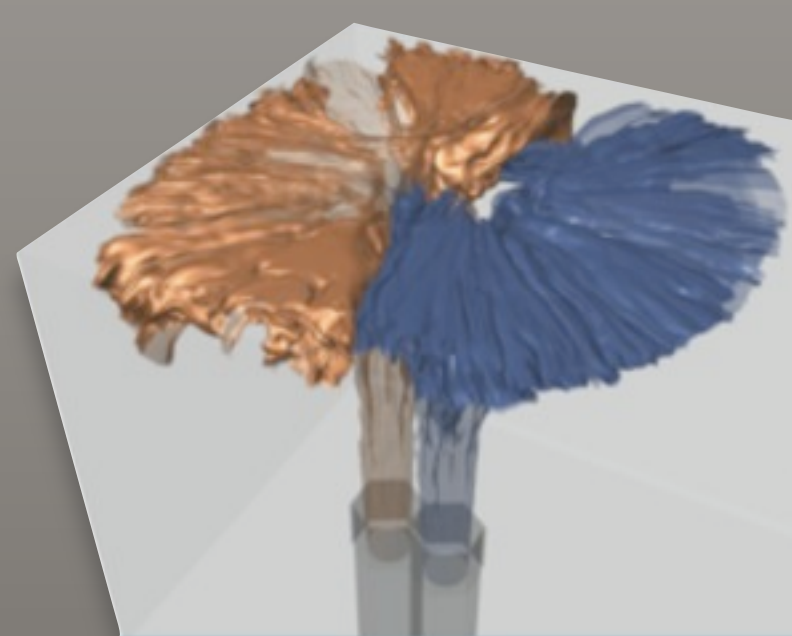
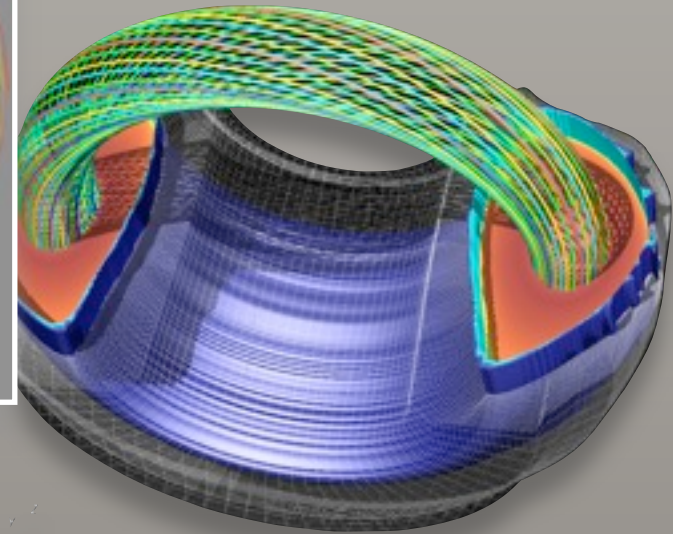
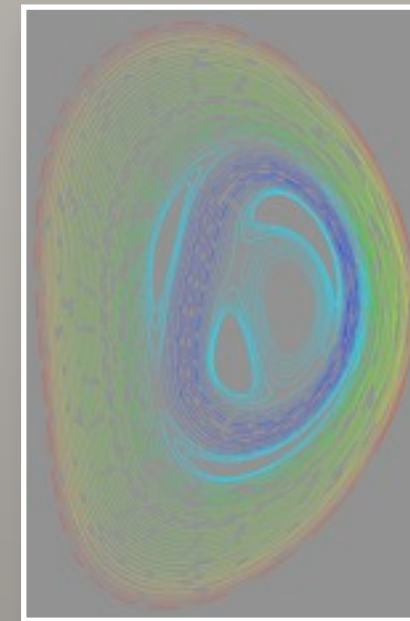
Block



Hybrid

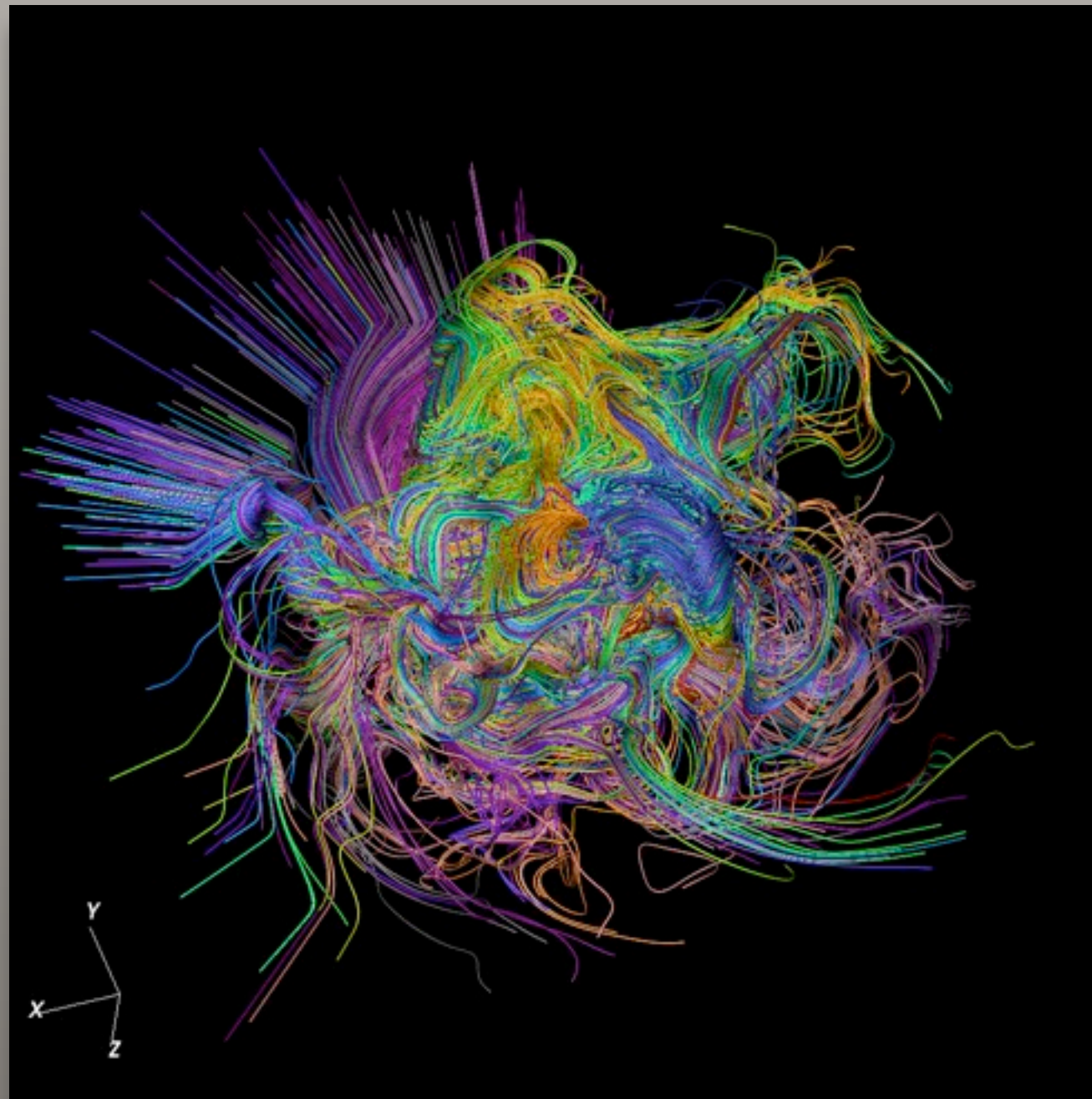
Continued development

- Algorithmic performance improvements
- Poincaré Analysis
 - Advanced termination criterion
 - Adaptively add additional seed points
- Stream surfaces



Magnetic Field Analysis for GenASiS

Understanding of entire streamlines is complicated



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